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WEST VIRGINIA

Agricultural Experiment Station

MORGANTOWN, W. VA.

PLAT EXPERIMENTS
WITH
COMMERCIAL FERTILIZERS
ON
CORN.

December 1892.

CHARLESTON, W. VA
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EXPERIMENTS WITH CORN.

By D. D. Johnson.

These experiments were made for the purpose of determining the effects of the artificial application of the leading elements of plant food, in various combinations, on the production of corn. By the leading elements of plant food, are meant, nitrogen, phosphoric acid and potash. Other elements contained in the soil are as essential to plant growth as these, but generally, nature has supplied them in sufficient quantities to answer all the demands of the plant; therefore one of the problems of great practical importance for the farmer to determine is, whether his soil is sufficiently supplied with nitrogen, phosphoric acid and potash. As these elements enter much more abundantly into the composition of plants than any of the others, it is very apparent that the continual production by, and the removal from the soil of crops grown thereon, will extract a large quantity of these elements of plant food from the soil, and thereby diminish its power of production.

Every observing farmer is familiar with the fact that while he can raise from seventy-five to one hundred bushels of corn per acre upon one part of his farm, another part of the farm will produce only from fifteen to twenty-five bushels per acre. He is also painfully cognizant of the fact that it requires more labor to produce the less number of bushels than it does to produce the greater. There are many causes for these failures, such as too much, or too little moisture, compactness of the soil, and other physical conditions, which incapacitates the plant for taking its food, or rendering the plant food contained in the soil unavailable. It is not, by any means, an easy task to overcome these difficulties, and in his struggle for the mastery, the vital, burning question comes to the farmer, "Will it pay? If not, why not?" Let the plant answer, for it alone can speak authoritatively.

In the following experiment, we have pursued this investigation in one direction only, that of the sufficiency of plant food contained in the soil, and have propounded these questions to the plants under treatment, and will endeavor to give our readers the benefit of their answers.

For the purpose of making thsee experiments, a plat of ground twelve rods wide by fifteen rods long was selected in each of the counties of Marshall, Doddridge, Upshur, Roane and Wood. Each of these plats was sub-divided into ten equal parts, each part being twenty-two feet wide, and one hundred and ninety-eight feet long. These sub-plats were separated from each other by a strip thirty-three inches wide, which was neither fertilized nor planted. We endeavored, in all cases, to secure plats of uniform fertility, as far as practicable. The fertilizers were prepared by thorough mixing at the Experiment Station at Morgantown, and shipped to the persons in charge of the out-stations. These persons were also furnished with the following instructions to guide them in all of their operations in making these experiments, and were supplemented by personal visits, or written communications by the Agriculturist.

MORGANTOWN, W. VA., Octoher 27, 1890.

SIR: You will please observe the following

INSTRUCTIONS:

For the government and control of persons in charge of the Experiment Farms of the Agricultural Experiment Station of West Virginia.

A complete record must be kept showing the following facts:

1st. What crop grew on the ground immediately preceding this experiment.

2nd. The date and depth at which the ground was plowed for this experiment.

3rd, The condition of the soil—whether cloddy or well pulverized, wet or dry—at the time of plowing and planting.

4th. The date and manner of planting the seed—whether drilled, sowed broadcast or otherwise.

5th. The date when the seed ' came up."

6th. The appearance of the plants every two weeks from the time of "coming up" to the time of harvesting; stating particularly the effects of drouth, too much rain, and frosts,

7th. A complete daily record of the temperature of the atmosphere at 6 A. M.; 12 M. and 8 P. M., and of the "Rainfall."

8th. The date of snowfall and the length of time it covered the wheat.

9th. The date of ripening, and harvesting; and the weight of the wheat crop (grain and straw) at the time of stacking; and the weight of corn crop (grain and fodder) at the time of husking.

10th. The weight of grain at time of threshing or husking, and number of measured bushels.

11th. The condition of the straw or fodder at the time of cutting.

12th. The condition of the grain at the time of harvesting and at the time of threshing or husking.

13th. Any abnormal condition of the plant or grain, during its growth; taking care to report any disease or insect attacking the plant, or grain, and preserving samples of the plants so attacked during the different stages of the disease; or ravages of the insect, also preserving specimens of the insect in its several stages of development.

Very Respectfully,
D. D. JOHNSON, Agriculturist.

The soil upon the plat used for experimental purposes at the out-station in the county of Wood, is of the alluvial character common to the Ohio river bottoms, and was cultivated and produced a crop of watermelons during the summer of 1890. For the experiment in corn, it was "broken up" with a two horse plow on the 17th day of April, 1891, to the depth of seven inches. At the time of breaking the ground was wet and cloddy. On the same day it was harrowed over once, and on the 20th day of April, the fertilizers were applied by sowing "broadcast" and thoroughly harrowed in On the 13th day of May, the ground was furrowed out, and the corn droppad and covered "by hand" three inches deep, the ground being very dry for that season of the year. The rows were 44.4 inches apart. and the hills 18 inches apart in each row. On the 20th of May, the corn commenced "coming up," about one-third of the grarn failing to germinate, whether on account of dry weather or inferior seed, is not known. The plants present a healthy appearance.

On the first day of June, the corn was re-planted, plowed and hoed, using a "bar-shear" plow, turning the soil away from the rows. On the 8th of June the corn was worked over with a cultivator, hoed, and thinned to two stalks in a hill. On the 15th and 22nd of June, and on the 8th day of July, the corn was plowed with a double shovel plow and hoed with the common field hoe. This was the last cultivation the corn received. It ripened and was cut and shocked on the 27th day of October. On the first day of December the corn was husked and the corn in the ear and the fodder were separately weighed. Mr. Stone is of the opinion that there was a loss of about 300 pounds of fodder caused by a wind storm blowing off the blades before the corn was "cut up." No allowance for this loss is made in the calculations in table "A."

The size of the plats are 16 rods, or one-tenth of an acre each, and by multiplying the number of pounds of each kind of fertilizer applied to each plat, by 10, we find the number of pounds per acre. At the Station, we purchase these fertilizers in the original package and mix them ourselves, as may be desired.

The following tables give the amount, kind, and aggregate cost per acre of the fertilizer applied to each plat; the number of pounds of corn and fodder produced on each plat, the number of bushels of corn per acre, and the increased yield, value and profit or loss caused by the use of the fertilizers.

In the calculations of all these tables, 70 lbs. of ear corn is required to make one bushel, all of the corn being in the ear. In the calculations of the cost per acre of the fertilizers applied, their cost per ton is used, while in the calculations for substitution of one for another, the commercial value of the potash, nitrogen and phosphoric acid contained in these fertilizers, is used, which will account for the slight difference from the statements of profit and loss as set forth in the tables.

TABLE A.

Showing the Results of the Application of Commercial Fertilizers in growing Corn, at the Out-Station at Selden, Wood County, in charge of S. S. Stone, Esq.

VARIETY—GOLDEN BEAUTY.

Number of Plat.	Fertilizers Applied.	Number of lbs. of Ear Corn.	Number of lbs. of Fodder.	Yield per Acre.		Increased Yield per Acre.		Value of Increas'd Yield per Acre.	Cost of Fertilizer per Acre.	Profits per Acre.	Loss per Acre.
		Lbs.	Lbs.	Bu.	Lbs	Bu.	Lbs	Dols	Dols	Do	Dol
2	16 lbs. of Kainit & 8 lbs. of Nit. of Soda..	637	550	91	. . .	27	22½	10.93	2.68	8.25	....
3	16 lbs. Mur. of Potash & 8 lbs of Dried Blood..	692	582	98	60	35	12½	14.05	5.00	9.05	....
4	16 lbs. of Acid Phosphate & 8 lbs of Mur. of Potash	590½	508¼	84	25	20	47½	8.27	2.88	5.39	....
5	8 lbs. of Dried Blood, 16 lbs. of Acid Phosphate & 8 lbs. of Mur. of Potash	591¾	487¼	84	37½	20	60	8.34	4.28	4.06	....
6	Nothing	445¾	500	63	47½	...	....	.....	.....	...	....
7	8 lbs. of Dried Fish & 16 lbs. of Kainit...	606½	507½	86	45	22	67½	9.18	1.92	7.26	....
8	8 lbs. of Dried Fish & 16 lbs. Sul. of Potash	514	417	77	50	14	2½	5.61	3.44	2.17	....
9	8 lbs. of Dried Fish & 16 lbs. of Mur. of Potash	507¾	413¾	72	37½	8	60	3.54	4.64	....	1.10
10	28 lbs. of Floats, 5/8 lbs. of Mur. of Potash, 1 9-10 lbs. of Sylvite & 2 3-10 lbs of Dried Fish	426	265¾	60	60	-2	56½	-1.12	2.23	...	3.35

TABLE B.

Showing the Results of the Application of Fertilizers in growing Corn at the Out-Station at West Union, Doddridge County, in charge of N. E. Duckworth, Esq.

VARIETY—GIANT BEAUTY.

Number of Plat.	Fertilizers Applied.	Number of lbs. of Ear Corn.	Number of lbs of Fodder.	Yield per acre.		Increased Yield per acre.		Val. of increased yield per acre.	Cost of Fertilizer per acre.	Profits per acre.	Loss per acre.
		Lbs.	Lbs.	Bu.	Lbs	Bu.	Lbs	Dols	Dols	Dol	Dol
1	Nothing	363	320	51	60	....	....	.....	.....	....	....
2	16 lbs. of Kainit & 8 lbs. of Nitrate of Soda	395	295	56	30	4	40	1.83	2.68	....	.85
3	16 lbs. of Mur. of Potash & 8 lbs. of Dried Blood	437	295	62	30	10	40	4.23	5.00	....	.77
4	16 lbs. of Acid Phosphate & 8 lbs of Mur. of Potash	455	277	65	....	13	10	5.26	2.88	2.38	....
5	8 lbs. of Dried Blood, 16 lbs. of Acid Phosphate & 8 lbs. of Mur. of Potash	465	200	66	20	14	40	5.83	4.28	1.55	....
6	3000 lbs. of Stable Manure	567	357	81	....	29	10	11.66	2.25	9.41	....
7	8 lbs. of Dried Fish & 16 lbs of Kainit..	415	290	59	20	7	30	2.97	1.92	1.05	....
8	8 lbs. of Dried Fish & 16 lbs of Sul. of Potash	460	2[illegible]0	65	50	13	60	5.54	3.44	2.10	...
9	8 lbs. of Dried Fish & 16 lbs. of Mur. of Potash	480	293	68	40	16	50	6.68	4.64	2.04	....
10	28 lbs. of Floats, 5-8 lbs. of Mur. of Potash, 1 9-10 lbs. of Sylvite and 2 3-10 lbs. of Dried Fish	490	288	70		18	10	7.26	2.23	5.03	....

TABLE C.

Showing the Results of the Application of Fertilizers in growing Corn, at the Out-Station at Wells, Mărshall County, in charge of Jeremiah Fish, Esq.

VARIETY—HICKORY KING.

Number of Plat	Fertilizers Applied.	Number of lbs. of Ear Corn.	Number of lbs. of Fodder.	Yield per acre.		Increased Yield per acre.		Val. of Increased Yield per acre.	Cost of Fertilizer per acre.	Profits per acre.	Loss per acre.
		Lbs	Lbs	Bu.	Lbs	Bu.	Lbs	Dols	Dols.	Dols.	Dols.
1	Nothing...........	358	440	51	10	....	....	......	......	......	......
2	16 lbs. of Kanit & 8 lbs. of Nitr. of Soda..............................	415	510	59	30	4	65	1.97	2.68	.....	.71
3	16 lbs. of Mur. of Potash & 8 lbs. of Dried Blood............................	386	465	54	20	....	—15	—.085	5.00	......	5.085
4	16 lbs. of Acid Phosphate & 8 lbs. of Mur. of Potash	424	510	60	40	6	5	2.43	2.88	......	.45
5	8 lbs. of Dried Blood, 16 lbs. of Acid Phosphate & 8 lbs. of Mur. of Potash.	550	630	78	40	21	5	9.63	4.28	5.35	......
6	Nothing	405	502	57	60	....	....	......	.....	......	.. ...
7	8 lbs. of Dried Fish & 16 lbs. of Kainit.	460	542	65	50	11	15	4.385	1.92	2.565	......
8	8 lbs. of Dried Fish & 16 lbs. of Sulp. of Potash.......................	505	602	72	10	17	45	7.06	3.44	3.72	......
9	8 lbs. of Dried Fish & 16 lbs. of Mur. of Potash......	500	590	71	30	16	65	6.77	4.64	2.13	.. .

TABLE D.

Showing the Results of the Application of Fertilizers in growing Corn, at the Out-Station at Spencer, Roane County, in charge of Hon. J. G. Shilling.

VARIETY—GOLDEN BEAUTY.

Number of Plat.	Fertilizers Applied.	Number Pounds of Ear Corn.	Number Pounds of Fodder.	Yield per Acre.	
		Lbs.	Lbs.	Bu.	Lbs
1	Nothing	No	Corn	Planted.	
2	16 lbs. of Kainit & 8 lbs. of Nitr. of Soda............	372¾	265	53	10½
3	16 lbs. of Mur. of Potash & 8 lbs. of Dried Blood......	350	388	50	
4	16 lbs. of Acid Phosphate & 8 lbs. of Mur. of Potash...	304	245	43	30
5 6	8 lbs. of Dried Blood, 16 lbs. of Acid Phosphate & 8 lbs. of Mur. of Potash	318	276	45	30
7	Nothing	No	Corn	Planted	
8	8 lbs. of Dried Fish & 16 lbs. of Kainit.............	605	410	86	30
9	8 lbs. of Dried Fish & 16 lbs. of Sulp. of Potash.......	133	257	19	
	8 lbs. of Dried Fish & 16 lbs. of Mur. of Potash.......	137	250⅛	19	40
10	28 lbs. of Floats, 5-8 lbs. of mur. of Potash, 19-10 lbs. of Sylvite & 2 3-10 lbs. of Dried Fish...............	127	249	18	10

TABLE E.

Showing the Results of the Application of Fertilizers in growing Corn, at the Out-Station at Buckhannon, Upshur County, in charge of Hon. Thos. J. Farnsworth.

VARIETY—GOLDEN BEAUTY.

Number of Plat.	Fertilizers Applied.	Number of Pounds of Ear Corn.	Number of Pounds of Fodder.	Yield per Acre.		Increased Yield per Acre.		Decreased Yield per Acre.		Value of Incr'sd Yield per Acre.	Cost of Fertilizer per Acre.	Profits per Acre.	Loss per Acre
		Lbs.	Lbs.	Bu.	Lbs	Bu.	Lbs	Bu.	Lbs	Dol	Dol	Dol	Dol
1	16 lbs. of Kainit & 8 lbs. of Nitr. of Soda	252.50	262.50	35	5	...	25	...	....	.14	2.68	...	2.51
2	16 lbs. of Mur. of Potash & 8 lbs. of Dried Blood	235.00	280 00	33	10	....	....	2	10	.86	5.00	....	5.86
3	16 lbs. of Acid Phosphate & 8 lbs. of Mur. of Potash	310.00	343 00	41	20	8	40	...	....	3.43	2.88	.55	....
4	8 lbs of Dried Blood. 16 lbs. of Acid Phosphate & 8 lbs. of Mur. of Potash	305.00	318 00	43	10	7	60	....	....	3.17	4.28	....	1.11
5	Nothing.	250.00	258.00	35	50	....	....	....	....	....	....	....	....
6	8 lbs. of Dried Fish & 16 lb of Kainit	260.00	205.00	37	10	1	30	...	...	.17	1.92	...	1.75
7	8 lbs. of Dried Fish & 16 lbs. of Sul. of Potash	330.00	320.00	47	10	11	30	...	....	4.57	3.44	1.13	...
8	8 lbs. of Dried Fish & 16 lbs. of Mur. of Potash	262.50	202 50	37	35	1	55	...	....	.71	4.64	....	3.93
9	28 lbs. of Floats, 5-8 lbs. of Mur. of Potash, 1 9-10 lbs. of Sylvite & 2 3-10 lbs of Dried Fish	225.00	225.00	32	10	...	....	3	40	-1.42	2.23	...	3.65

Let us examine table "A," and ascertain, if possible, what answers it gives to our questions. For the sake of convenience, we will multiply the size of the plat, and the amount of each kind of fertilizer put therein, by ten, to enable us to make all of our calculations and comparisons by the acre. We will further ascertain the amount of potash, nitrogen and phosphoric acid contained in each of the fertilizing elements used. We find that plat 6, without any fertilization whatever, produced 445¾ lbs. of ear corn, or at the rate of 63 bushels and 47½ lbs, of corn per acre. By the application of Kainit at the rate of 160 lbs., equal to 22.4 lbs. of potash and 80 lbs. of nitrate of soda, equal to 12 lbs. of nitrogen per acre, we have a yield of 91 bushels, or an increase of 27 bushels and 22½ lbs. per acre at a cost of $2.68 for fertilizers. On plat 7 we apply the same amount of Kainit to supply the potash, but for the nitrogenous fertilizer, we use 80 pounds of dried fish, equal to 6 lbs. of nitrogen and 3.6 lbs. of phosphoric acid, and have a yield at the rate of 86 bushels and 45 lbs. per acre; an increase over plat 6 of 22 bushels, and 67½ lbs per acre at a cost of $1.92 per acre for fertilization.

But let us enquire what effect the substitution of 80 lbs of dried fish for the 80 lbs. of nitrate of soda produced upon the yield and profits of the crop. We have diminished the nitrogen 6 lbs. which at 19 cts. per lb., amounts to $1.14, and have added 3.6 lbs. of phosphoric acid, which, at 8 cts. per lb. amounts to 28.8 cts., making the net reduction in the cost of fertilizers of 85.2 cts. But we have a reduction in the yield of corn of 4 bushels and 25 lbs., worth 1.74.2, making a net loss of 88 cts., by the substitution of dried fish for nitrate of soda.

Again, in continuation of the inquiry as to the effects of the application of potash and nitrogen, let us compare the results on plats 3 and 9. On plat 3 we have applied muriate of potash at the rate of 160 lbs., equal to 80 lbs. of potash and 80 lbs. of dried blood, equal to 9.6 lbs of nitrogen per acre, producing a yield of 98 bushels and 60 lbs per acre, an increase over plat 6 of 35 bushels and 12½ lbs., at a cost for fertilizers of $5; while on plat 9, we have the same amount of potash, but substitute 80 lbs. of dried fish, equal to 6 lbs. of nitrogen and 3.6 lbs. phosphoric acid producing a yield of 72 bushels and 37½ lbs., an increase over plat 6 of 8 bushels and 60 lbs., but a decrease from plat 3 of 26 bushels and 22½ lbs. by the substitution of 3.6 lbs. of phosphoric acid for 6 lbs. of nitrogen. Query. Was this decrease caused by this substitution?

These ten plats are located on the second or upper bottom of the Ohio valley, and are separated from the first or lower bottom by a steep, sandy bluff, and are laid out parallel with the bluff. While there appears to be no material difference in the natural fertility of plat 1 to 7, the ground on plats 8, 9 and 10, slightly slopes towards the bluff; and becomes more and more sandy and gradually decreases in natural fertility. We, therefore, conclude that the application of different fertilizers to plats 7, 8, 9, and 10 does not wholly account for the difference in the production of these plats

On plat 4, we have applied acid phosphate at the rate of 160 lbs., and muriate of potash at the rate of 80 lbs. per acre. On plat 5 we apply the same amount of acid phosphate and muriate of potash and add thereto dried blood at the rate of 80 lbs. equal to 9.6 lbs. of nitrogen per acre, without producing any material increase of the crop over that produced by plat 4.

By a comparison of plats 2 and 3, we find that by the application of kainit at the rate of 160 lbs. per acre, containing 22.4 lbs. of potash, costing 88 cts., and 80 lbs. of nitrate of soda containing 12 lbs. of nitrogen, costing $1.80, we increase the yield 27 bu. and 22 & 1-2 lbs. per acre, while, by the application of muriate of potash, at the rate of 160 lbs. per acre, containing 80 lbs, of potash, costing $3.60 and 80 lbs. of dried blood containing 9.6 lbs. of nitrogen, costing $1 40, we increased the yield 35 bu. and 12½ lbs. per acre. Suppose the nitrogen used on these plats produced 50 and 5-6 lbs. of corn for each pound of nitrogen applied, as is fully shown hereafter, then the 22 4 lbs. of potash applied in the form of kainit produced an increased yield of 18 bu. and 43½ lbs., and the 80 lbs. of potash applied in the form of muriate of potash produced an increased yield of 28 bu. and 14½ lbs. Therefore, each pound of potash supplied by kainit produced 58.17 lbs. of corn, and each pound of potash supplied by muriate of potash, produced 24.68 lbs. of corn.

Exclusive of freight and handling, the kainit cost $11 per ton and the Muriate of Potash $45 per ton. Kainit contains 14 per cent., and muriate of potash 50 per cent. of potash. Hence, a pound-of potash contained in kainit cost 3.93 cts., and a pound of potash contained in muriate of potash cost 4.5 cts ; therefore, the cost of potash contained in kainit required to produce one bushel of corn is 4.73. cts and the cost of potash contained in muriate of potash required to produce one bushel of corn is 12.94 cts.

For the purpose of determining the effects of nitrogen and the comparative merits of potash and kainit, let us first compare plats 5 and 7. Plat 5 has a "complete fertilizer," and to supply the necessary plant food, we have used 8 lbs. of muriate of potash, containing 4 lbs. of potash ; 16 lbs. of acid phosphate, containing 2.24 lbs. of phosphoric acid, and 8 lbs. of dried blood containng .96 lbs. of nitrogen, or at the rate per acre of 40 lbs. of potash, 22.4 lbs. of phosphoric acid and 9.6 lbs. of nitrogen, producing at the rate of 84 bu. and 37½ lbs. of corn per acre ; an increased yield of 20 bu. and 60 lbs.

In plat 7, we also have a "complete fertilizer," in greatly reduced quantities, but to supply the nitrogen and phosphoric acid, we use 8 lbs. of dried fish containing (.6) six-tenths of a pound of nitrogen, and (.36) thirty-six hundredths of a pound of phosphoric acid, and to supply the necessary potash, we use 16 lbs. of kainit, containing 2.24 lbs of potash, or at the rate per acre of 6 lbs. of nitrogen, 3.6 lbs. of phosphoric acid, and 22.4 lbs. potash, producing at the rate of 86 bu. and 45 lbs. of corn per acre, an increased yield of 22 bu. and 67½ lbs. Here we almost eliminated the phosphoric acid, and reduced the nitrogen 37½ per cent., and the potash 44 per cent., yet we have an increased yield of plat 7 over plat 5 of 2 bu., 7½ lbs.

Now let us inquire whether the substitution of Kainit for the Muriate of Potash caused the increase? In this table (A) we have no data by which we can definitely determine the effects of the application of Phosphoric Acid, but from an inspection of the results produced on Plats 4 & 5, and comparing these results with that produced on Plats 2, 3 & 7, we may safely infer that the applications of Phosphoric Acid to the soil contained in these plats produced no material effect. By a further comparison of Plats 2 & 7, we find that Plat 2 has 6 lbs. per acre more Nitrogen than Plat 7 and that it produced 4 bu. and 25 lbs. more of corn than Plat 7. Supposing that the Nitrogen applied produced this increased yield, we then find that one pound of Nitrogen produced an increased yield of 50 and 5.6 lbs. of corn. We have already seen that there were 12 lbs. per acre applied to Plat 2, and 6 lbs. to Plat 7. Deducting from the increased yield of each of these Plats, the amounts produced by the application of Nitrogen, we find the increased yield produced by the application of 22.4 lbs. of Potash in the form of Kainit on Plat 2 to be 18 bu. and 42

1 2 lbs., and on Plat 7, 18 bu. and 42 1-2 lbs., exactly the same. Now, let us ignore the Phosphoric Acid applied to Plat 5, and deduct the increased yield produced by 9.6 lbs. of Nitrogen (amounting to 6 bu. and 68 lbs) from the gross increased yield, then we have remaining 13 bu. and 62 lbs. as the increased yield produced by the application of 40 lbs. of Potash in the form of Muriate of Potash; an increased yield of 24.3 lbs. of corn for each pound of potash applied; agreeing almost exactly with Plat 3, in the quantity of potash contained in Muriate of Potash required to produce one bushel of corn. Hence, it is clear that the Kainit not only produced the increased yield of 2 bu. and 7 1-2 lbs. but also made up the deficit caused by the diminution of the Nitrogen applied to Plat 5, the actual increase being 4 bu. and 50½ lbs. We find, therefore, that the application of 80 lbs. of Muriate of Potash, costing $1.80 produced an increased yield of 13 bu and 62 lbs and the application of 160 lbs. of Kainit costing 88 cents, produced an increased yield of 18 bu. and 42 lbs.

The land upon which the experiment was conducted in the county of Doddridge is commonly described as "hill land," having a northern and western exposure. The soil is a "clay loam" and had been in grass, and used as a pasture field for several years previous to the experiment. The ground was plowed on the 18th and 19th, and the fertilizer applied by sowing broad cast, and harrowed in on the 30th day of March, 1891. The corn was planted on the 30th day of April. Because of dry weather, the corn did not come up until about the 15th day of May, and did not make a very good "stand," but it was at once replanted, and the "replant" came up in a few days thereafter. The corn was cultivated on the 30th day of May, 14th day of June and 25th day of June.

To what extent does the result of the application of Kainit and Muriate of Potash to the soils on the experiment grounds at West Union, correspond with the results obtained by their application to the soil on the experiment plats at Selden? By an examination of the formulas for plats 4 and 5, table B, we find that the same amount of Phosphoric Acid and Potash was applied to each of these plats, and that to plat 5 was applied 8 lbs. of Dried Blood. The increased yield of plat 5 over plat 4 which we may presume was caused by the use of Dried Blood, was 110 lbs. or nearly 11.46 lbs. of corn for each pound of nitrogen applied. Subtracting the increased yield produced by nitrogen (2 bu. and 66¼ lbs.) on plats 2 and 7 from the total increased yield of these two plats, we have 9 bu. and 3 3 4 lbs. as the increased yield caused by the application of Kainit, or 14 15 lbs of corn for each pound of Potash used. Eliminating in the same manner the increased yield produced by nitrogen on plats 3 and 9, we have an increased yield of 24 bu and 51¼ lbs, as the increased yield of these two plats, caused by the application of Muriate of Potash, or 10.82 lbs. of corn for each pound of Potash used. The increased yield for each pound of potash applied was a little more than 37.7 per cent. more for the Kainit than for the Muriate of Potash.

The land used in the experiment in Marshall county is a steep hill side with a north-western exposure, and the soil is a dark clay loam. A crop of grass had been grown on this land the previous year. The ground was broken up in April, the fertilizer sown broadcast and "harrowed in" and the plats planted on the 13th day of May, and given the usual cultivation during the growing season.

Pursuing the same methods in our calculations that were adopted in tables A. and B., we find that in table C., the increased yield caused by the application of potash to plats 2 and 7 is 14 bu. and 50 lbs. and the increased yield caused by the application of potash to plats 3 and 9 is 15 bu., or for the kainit, an increased yield of nearly 21.03 pounds of corn for each pound of potash applied, and for the muriate of potash, an increased yield of nearly 6.25 lbs. of corn for each pound of potash applied.

Tables D. and E. confirm the claims of kainit as a potash fertilizer for corn, and seem to give it the decided preference, but as we have no data of the increased yield in table D., and as the yield of plats 7 and 9, of this table, and plats 2 and 7 of table E are all abnormal and inexplicable, we shall not attempt to analyse or compare their results with the results obtained in the experiments set forth in tables A, B, and C.

Let us inquire what are the comparative merits of muriate of potash and sulphate of potash as a fertilizer for corn as shown in these tables? Remembering that muriate of potash, containing 50 per cent of potash, costs $45 per ton, and that sulphate of potash, containing 25 per cent of potash, costs $30 per ton, or to state it more plainly, the potash contained in muriate of potash costs 4 5 cts. per pound, and the potash contained in sulphate of potash costs 6 cts. per pound; by a comparison of plat 8, with plat 9 of all these tables, we may be able to answer this inquiry.

Tables A, D, and E seem to show a very decided preference for sulphate over muriate of potash, but the greatly diminished natural fertility of the soil in plat 9 from that of plat 8 in table A, and the same conditions existing in the fertility of the soil in plats 8 and 9, table D, and the abnormal yield of plat 8 in table E, would not justify us in comparing the yield of these plats with the other and deducing therefrom a conclusion as to the relative merits of the fertilizers used. But in tables B and C we encounter no such difficulty, as no appreciable difference could be seen in the natural fertility of the soil in plats 8 and 9 at each of the out stations represented by these tables. Supposing that dried fish produced the same effect on each of these plats at each of these stations, and deducting the amount thus produced (as heretofore determined) from the increased yield of these plats, we find that we have an increased yield in table B of 22.29 lbs. for each pound of potash contained in Sulphate of Potash, and an increased yield of 13.77 pounds for each pound of potash contained in Muriate of Potash, and in table C. an increased yield of 29.19 pounds of corn for each pound of potash contained in Sulphate of Potash, and an increased yield of 13.95 pounds of corn for each pound of potash contained in Muriate of Potash.

In the use of Floats as a fertilizer, the results obtained in these experiments are very unsatisfactory. The decreased production of plats 10 in tables A, D and E, we are convinced, was caused by the decrease in the natural fertility of the soil in these plats. In plat 10, table B, where the natural fertility of the soil was maintained, we have a very gratifying increase in the yield. On plat 6, table B, we applied 3,000 pounds of stable manure, producing an increased yield at the rate of 29 bu. and 10 lbs. per acre, giving us a net profit of $9.41. As stable manure is a thing which must be produced, whether it be utilized or not, we have fixed its price at what it costs to spread it upon the field. It will be seen that this plat yielded a larger profit than any other plat in the whole series of experiments. Although great care was exercised in the selection, we have found it almost impossible to secure ten consecutive plats possessing the same characteristics, and having a uniform natural fertility. Under such circumstances, of course, there are elements of uncertainty entering into all these experiments. In our efforts to state the facts brought out by the results as stated in these tables, we have endeavored, as far as possible, to eliminate all uncertain factors, and give the conclusions which these experiments seem to warrant.

The results of the application of potash as a fertilizer, in these experiments, as set forth in the several tables, may be summarized as follows:—

Table A. 1 lb. of Potash contained in Kainit produced 58.17 lbs. corn.

Table A. 1 lb. of Potash contained in Mur. of Potash produced 24.68 lbs Corn.

Table A. The cost of Kainit to produce 1 bu. of Corn is 4.73 cts.

Table A. The cost of Mur. of Potash to produce 1 bu. of corn is 12.94 cts.

Table B. 1 lb. of Potash contained in Kainit produced 14.79 lbs. Corn.

Table B. 1 lb. of Potash contained in Mur. of Potash produced 10.82 lbs. of Corn.

Table B. 1 lb. of potash contained in Sulph. of Potash produced 22.29 lbs. Corn.

Table B. The cost of Kainit to produce 1 bu. of Corn is 18.60 cts.

Table B. The cost of Mur. of Potash to produce 1 bu. of Corn is 29.25 cts.

Table B. The cost of Sulph. of Potash to produce 1 bu. of Corn is 18.57 cts.

Table C. 1 lb. of Potash contained in Kainit produced 21.03 lbs. Corn.

Table C. 1 lb. of Potash contained in Mur. of Potash produced 6.25 lbs Corn.

Table C. 1 lb. of Potash contained in Sulph. of Potash produced 29.19 lbs. Corn.

Table C. The cost of Kainit to produce 1 bu. of Corn is 13.07 cts.

Table C. The cost of Muriate of Potash to produce 1 bu. of Corn is 49.68 cts.

Table C. The cost of Sulph. of Potash to produce 1 bu. of Corn is 14.38 cts.

The average increased yield produced by 1 lb. of potash contained in Kainit is 31.33 lbs.

The average increased yield produced by one pound of Potash contained in Sulphate of Potash is 25.74 lbs.

The average increased yield produced by 1 lb of Potash contained in Muriate of Potash is 15.91 lbs.

The average cost of Kainit required to produce 1 bu. of corn is 9.06 cts.

The average cost of Sulphate of Potash required to produce 1 bu. of corn is 16.32 cts.

The average cost of Muriate of Potash required to produce 1 bu. of corn is 19.35 cts.

TABLE F.

Analysis of soils taken from the several experiment Out-Stations, by Rudolf de Roode, Ph. D., Chemist.

Laboratory Number.	Owner of Farm From Which Samples of Soil Were Taken.	Percentage fertilizing elements.			
		Nitrogen.	Phos. Acid.	Potash.	Lime.
12	S. S. Stone, Esq., Seldon, Wood Co., W. Va.	.132	.153	.243	.104
13	A. P. Sinnet, Esq., Charleston, Kanawha Co., W. Va.	.138	.121	.593	.335
14	Jeremiah Fish, Esq., Wells, Marshall Co., W. Va.	.131	.167	.808	.451
15	N. E. Duckworth, Esq., West Union, Doddridge Co.	.184	.105	.405	.181
16	Thomas J. Farnsworth, Esq., Buckhannon, Upshur Co., W. Va.	.215	.103	.705	.062
17	Col. John A. Robinson, Patterson's Depot, Mineral Co., W. Va.	.131	.088	.481	.055
46	S. S. Stone, Esq., Selden, Wood Co., W. Va.	.091	.115	.250	.081
47	Jeremiah Fish, Esq., Wells, Marshall Co., W. Va.	.184	.185	.516	.404
48	S. S. Stone, Esq., Selden, Wood Co., W. Va.	.112	.184	.459	.116
49	Hon. Thomas J. Farnsworth, Buckhannon, Upshur Co.	.171	.095	.781	.059
50	N. E. Duckworth, Esq., West Union, Doddridge Co.	.177	.121	.888	.076
51	J. G. Schilling, Esq., Spencer, Roane Co., W. Va.	.091	.093	.401	.111
53	Edward Kyle, Esq., Cox's Landing, Cabell Co.	.078	.211	.479	.081

Samples of the soils were taken from all, except one of the stations selected for experiments in wheat in 1890, and also from the stations selected for experiments in corn in 1891, and delivered to the Chemist for analysis. Table F. gives the results of these analyses. Numbers 12, 13, 14, 15, 16, 17 and 53 are the samples taken from the wheat plats, and numbers 47, 48, 49, 50 and 51 are the samples taken from the corn plats. No. 49 is a sample taken from another part of the farm of Mr. Stone.

Prof. Lupton states the amount of Potash usually found in a fertile soil to be 0.200 per cent. The "American Farm Book" by R. L. Allen, and revised and enlarged by Lewis F. Allen, gives an analysis of four soils of "arable lands of great fertility" which states the percentage of Potash contained in them to be 0.140, 0.120; 0.240 and 0.100 respectively. It will be seen that in none of the cases given does the potash exceed twenty-four hundreths of one per cent. while in the analysis of our soils as shown in this table, the percentages of Potash in every case exceeds that amount, the lowest being 0.243, and the highest 0.888, showing that they contain a great deal more Potash than is essential to a fertile soil. The table given by Prof. Lupton requires 0,450 or a little less than one-half of one per cent of phosphoric acid, and nearly six per cent of lime, and the "American Farm Book" requires about one per cent of nitrogen and gives several instances of very fertile soils containing from 22 to 37.5 per. cent of lime. If these be the correct standards, then our soils as shown by these analyses contain an abundance of potash, and fall very far below the required amount of phosphoric acid, nitrogen and lime. Almost all over West Vriginia there is an abundance of limestone and coal, thus giving the farmers at a very small cost, the means of increasing the productiveness of their soils to a wonderful extent.

These analyses undoubtedly show the percentage of nitrogen, phosphoric acid, potash and lime contained in these soils, but they certainly fail to show the percentage of these fertilizers which are available as plant food Let us examine No. 48, which shows the analysis of samples of soil taken from the land of Mr. Stone, upon which the experiment shown in Table A, was made. Suppose that 18 cubic feet of this soil weighs 2000 lbs., then the soil covering one acre to the depth of six inches, weighs 2,420,000 lbs., containing, according to this analysis, 2710 lbs. of nitrogen, 4452 lbs. of phosphoric acid and 11,107 lbs. of potash. The largest yield per acre (plat 3) is 6920 lbs of corn, containing 97.50 lbs. of Nitrogen, 39.51 lbs. of Phosphoric Acid, and 32.66 lbs. of Potash, and 5,820 lbs. of fodder containing 102,51 lbs. of Nitrogen, 31.54 lbs. of Phosphoric Acid, and 51.73 lbs. of Potash, the corn and fodder together containing 200.01 lbs. of Nitrogen, 71.05 lbs. of Phosphoric Acid and 84.39 lbs. of Potash.

The yield per acre without artificial fertilization (Plat 6) is 4,457.5 lbs. of corn containing 62.80 lbs. of Nitrogen, 25.45 lbs. of Phosphoric Acid and 21.04 lbs. of Potash and 5,000 lbs. of fodder, containing 88.15 lbs. of Nitrogen, 26.10 pounds of Phosphoric Acid and 44.45 lbs. of Potash ; the corn and fodder together containing 150.95 lbs. of Nitrogen, 51.55 lbs. of Phosphoric Acid and 65.48 lbs. of Potash. Here we have contained naturally in this soil Nitrogen enough to produce eighteen, Phosphoric Acid enough to produce eighty-six and Potash enough to produce one hundred and sixty-nine such crops, proving conclusively that a very large quantity of these elements of plant food are not available in their present condition. The ratio of availability seems to be inversely as to the amount of each of these elements contained in the soil, but here we encounter another unknown quantity in the amount of Nitrogen supplied from the air. We find that by the application of all three of these elements of plant food (Plat 5, Table A.,) we have an increased yield of 20 bu. and 60 lbs of corn, and a decreased yield of 12¾ pounds of fodder.

By the omission of the phosphoric acid, and doubling the amount of potash applied, we have an increased yield (plat 3.) of 35 bu. and 12 1-2 lbs of corn and 820 lbs. of fodder. On this plat (3), we applied at the rate of 80 lbs. of Potash, and 9 6 lbs. of Nitrogen, and have recovered in the increased yield 18 90 lbs. of Potash, 49.90 of Nitrogen and 18.50 lbs. of Phosphoric Acid. Here we recover 23 62 per cent. of the Potash and receive back more than five times the amount of Nitrogen applied, and 18.50 lbs. of Phosphoric Acid. In Plat 3, we applied at the rate of 22.4 lbs. of Potash and 12 lbs. of Nitrogen per acre, and have an increased yield of 27 bu. and 23 1-2 lbs. of corn and 500 lbs. of fodder, returning to us in the increased yield 13.47 pounds of Potash, 36.78 lbs. of Nitrogen and 13.60 lbs of Phosphoric acid. Here we recover in the increased yield a little more than 60 per ct. of the Potash, and three times the amount of Nitrogen applied; and in addition thereto, we have 13.60 lbs. of Phosphoric acid.

These facts suggest the following very important inquires, which we shall not attempt to answer:

What effect does the potash applied have upon the Potash, Nitrogen and Phosphoric Acid or either of them, already contained in the soil? Is the Nitrogen and Phosphoric Acid naturally in this soil, available as plant food and does the plant refuse to appropriate it because of the non-availability of the Potash naturally in this soil?

My attention has been called to the analysis of some very fertile and productive soils containing a much smaller precentage of Potash, Nitrogen and Phosphoric Acid, but a much larger quantity of lime than any of the soils mentioned in these tables.

In conclusion, we desire to call the attention of West Virginia farmers to the following extract from Prof. Lupton's "Elementary Principles of Scientific Agriculture:" "The applications of lime to soils furnishes at least one mineral constitutent to plants, one, however, that generally exists in soils, and hence its valuable and often surprising effects are not to be attributed to the plant food it contains so much as to the other important purposes which it serves. Its alkaline properties cause it to neutralize acids, which sometimes exist injuriously in soils. It also renders stiff clays light and mellow; and aids in the decomposition of organic substances, and of some insoluble inorgangic compounds. In other words, lime corrects "sourness" in lands, destroys excess of vegetable matter, lightens heavy clay soils and releases potash for the use of plants by decomposing silicates."